

# **SUSTAINABILITY:**

## *A Tale of Three Scales*

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# TABLE OF CONTENTS

Climate Analysis . . . . .

Nordhavn . . . . .

Copenhagen International School . . . . .

The Silo . . . . .

Drawing Conclusions . . . . .

References . . . . .

.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
																							3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
																							7
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
																							17
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
																							27
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
																							35
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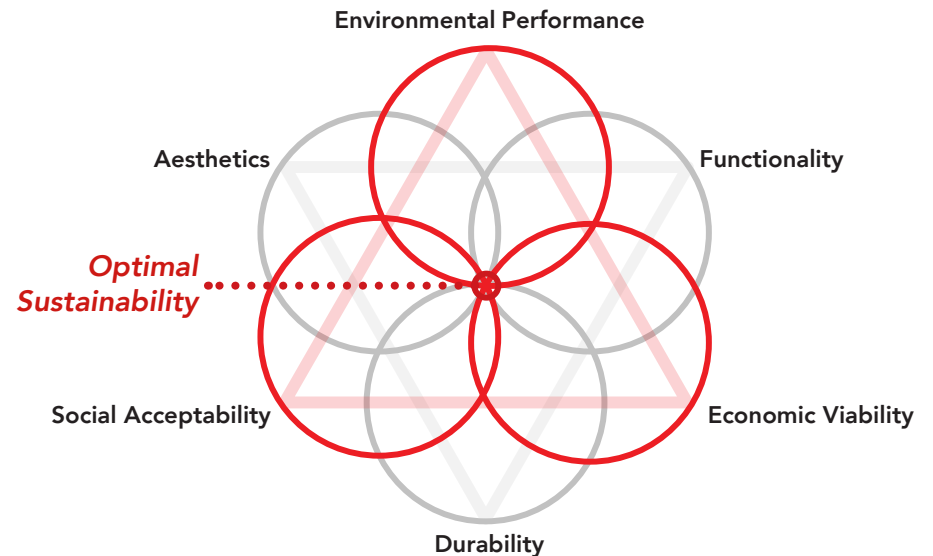
# INTRODUCTION

**Sustainability.** Sustainability is a very broad area of focus as it is cultivated by many different definitions and is described as consisting of many different elements.

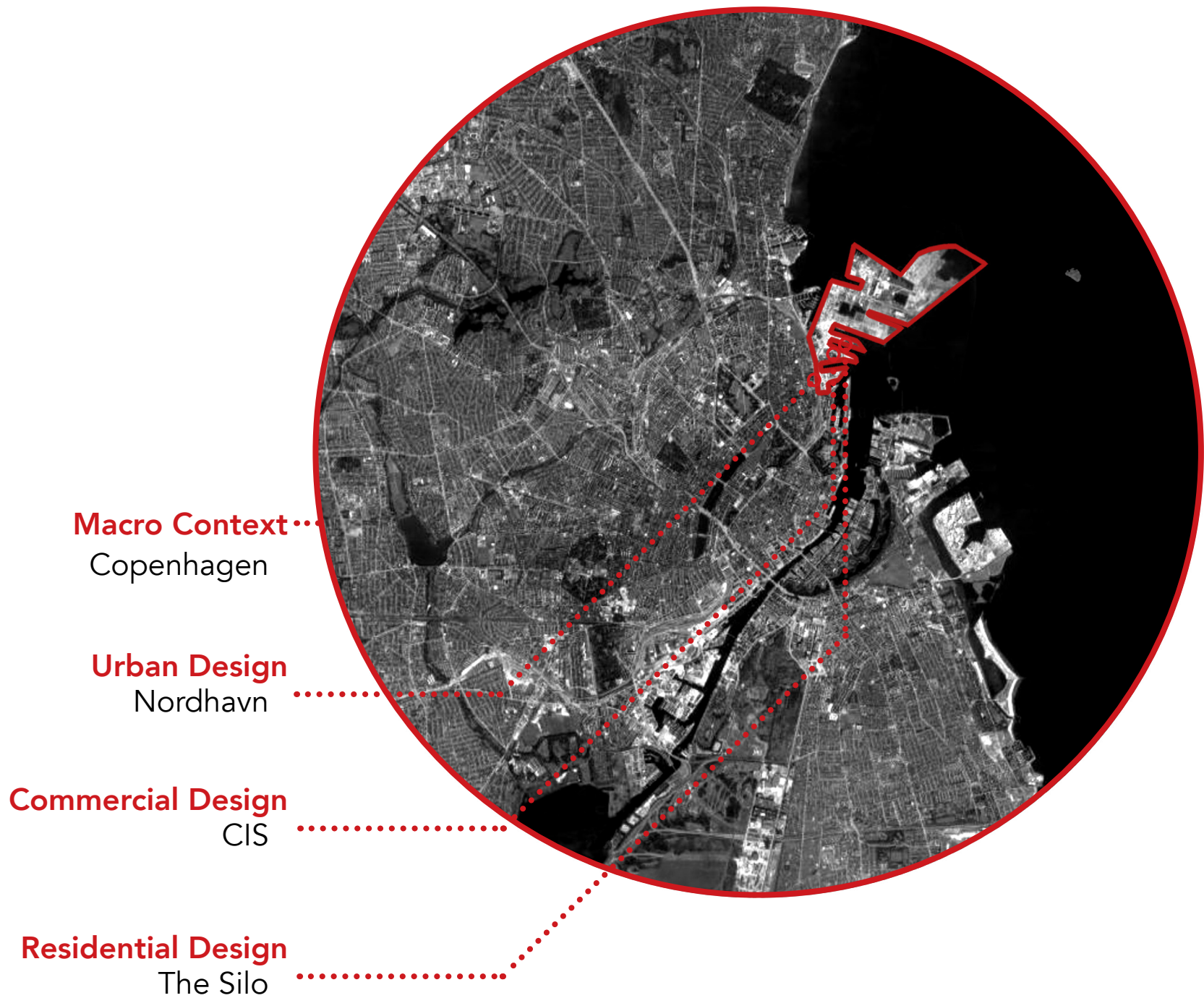
**Two major descriptions** of sustainability were created in attempt to sharpen these definitions. The first, created by Vitruvius, an Italian architect during the later first century B.C., states that sustainability can be broken down into three categories: Utilitas, Firmitas, Venustas. Translated, a sustainable building can be described as being aesthetically pleasing, functional, and durable. The second major description also breaks sustainability into three pillars: environmental performance, social acceptability, and economic viability. Both forms state that it takes all three of these categories in unison to create a sustainable building, and without all three the building will not work at its full potential.

In my research, I will study sustainability at three different design scales: **urban design, commercial**

**design, and residential design.** Within each of these three scopes, I will distill my research into the unique set of six distinguishing factors of sustainability: **environmental performance, aesthetics, social acceptability, functionality, economic viability, and durability.** This allows me to keep a specific and unified approach when looking at each scale, and to make comparisons between each scale.







**Macro Context**...

Copenhagen

**Urban Design**

Nordhavn

**Commercial Design**

CIS

**Residential Design**

The Silo

# CLIMATE ANALYSIS

## Copenhagen, Denmark

Temperature:	<b>Average: 8.5 Degrees Centigrade</b> Hottest Month: July (17) Coldest Month: January (0)
Humidity:	<b>Average: 79.0% Humidity</b> Most Humid: January (84%) Least Humid: May (76%)
Rainfall:	<b>Average: 47.5 mm per Month</b> Rainiest Month: October Driest Month: May
Snowfall:	<b>Average Snowfall: 2.54 mm</b> Most Snow: February (5.08 mm)
Sunlight:	<b>Average: 12 hours per Day</b> Most Sunlight: June (17) Least Sunlight: January (7)
Cloudiness:	<b>Average Cloud Cover: 57%</b> Least Clouds: July (42%) Most Clouds: December (71%)
Wind:	<b>Average Wind Speed: 20 kph</b> Least Wind: July (17kph) Most Wind: January (24 kph)



## Minneapolis, MN, USA

<b>Average: 8.5 Degrees Centigrade</b> Hottest Month: July (24) Coldest Month: January (-9)
<b>Average: 15.5% Humidity</b> Most Humid: June (31%)
<b>Average: 54.6 mm per month</b> Rainiest Month: June Driest Month: January
<b>Average Snowfall: 7.62 mm</b> Most Snow: December (12.7 mm)
<b>Average: 11.5 hours per Day</b> Most Sunlight: June (15) Least Sunlight: December (8)
<b>Average Cloud Cover: 44.5%</b> Least Clouds: July (29%) Most Clouds: February (60%)
<b>Average Wind Speed: 15 kph</b> Least Wind: August (12 kph) Most Wind: March (18 kph)

An analysis of two different climates, being Minneapolis, Minnesota (Midwestern United States) and Copenhagen Denmark (Southern Scandinavia), a conclusion can be drawn deeming different sustainable features are **transferable from one location to the other**. This climate analysis deciphers the parts of the two climates that are relatively similar and those that are dissimilar in order to understand which sustainable methods will or will not work in the other location.

By viewing the chart and comparing the two different climates, it is shown that both location's climates are relatively similar. Subtle differences exist



Copenhagen, Denmark Floods

within the Copenhagen's winters and the Minnesota summers, but on an annual basis, many different categories align very closely. Some standout weather categories that do not match between the two locations are the wind speeds, amount of snowfall, and the humidity. Since these categories are not transferable between Copenhagen and Minneapolis, sustainability tools that include these climate categories will not work in all of their completeness. Through this analysis, the different tools that are presented will be based off of those that are transferable to and from both locations



Minneapolis, MN, USA Snow Storms







# NORDHAVN

## *Scale One*

The Nordhavn Development is a brand-new expansion to the city of Copenhagen, located on the peninsula extending out into the Baltic Sea to the North of the Copenhagen City Center. The project was designed through a competition with 180 total entries for the future district. **Three equal winning firms were selected: COBE, SLETH, and Rambøll.** Each firm had three months to work as a team to detail out the master process plan (Nordhavnen: Inner Nordhavn). A major difference between this development

process, however, and other master planning processes in that it intentionally introduced elements that embraced future adaptability. The final masterplan that was created from the three selected winners was presented in 2009 with an estimated completion date of 2050. Comprising itself of many different sustainable urban design elements, Nordhavn is to be considered the **most sustainable district of Copenhagen** and possibly even all of Europe (Nordhavnen: Inner Nordhavn).





# ENVIRONMENTAL PERFORMANCE

The masterplan of Nordhavn is said to be comprised of three major parts that allow it to be a model for sustainable development and sustainable design: Use of renewable energy, Recycling, and the use of sustainable transport. The 2010 Municipal Strategy for Copenhagen entitled "Green growth and quality of life," states that Nordhavn, being comprised of islets and canals, is considered a green laboratory with a **sustainable traffic structure** and **sustainable energy supply** (Nordhavnen: Inner Nordhavn). Specifically, in the future, the metro (a very prevalent source of sustainable traffic already used

throughout Copenhagen) will be connected to different sections of Nordhavn. Lastly, since the entire district will be comprised on a peninsula, it will be one of the most compact districts of Copenhagen. This ensures that **resource and energy consumption can be reduced** and short distances between facilities promotes greater utilization of **foot and cycle traffic** rather than use of an automobile (Nordhavnen: Inner Nordhavn).

"Creating the sustainable city of the future is the overall vision for Nordhavn as a district of Copenhagen. A sustainable city is not only a matter of the environmental responsibility, but also of social diversity and the addition of value."

- **BY & HAVN**  
Greater Copenhagen Area Development Firm



# AESTHETICS (VENUTAS)

Nordhavn, in its current state, is one of the many industrial shipping yards located in and around Copenhagen. This area has an identity of its own, being riddled with a mix of old buildings (**silos, factories, etc.**) and brand new buildings incorporating this identity. The transition from shipping yard to city district will act as a symbol of Copenhagen's transformation from a city fostered on industries to a city fostered on Knowledge (Nordhavnen: Inner Nordhavn). One of the many difficulties of the project is being able to create an aesthetically pleasing city district while also being able to **preserve the past identity** of the area. A question that has to be kept in mind while designing this entire area is: 'Which is more important: history or beauty?'

The project that is currently underway is considered 'Inner Nordhavn'. This area of the district is an environment with a **special cultural heritage** that includes buildings worth preserving and a visual

narrative of the area's history. The future for the entire district of Nordhavn will be based off of the success of the area of 'Inner Nordhavn' which is now under construction. As of now, the project has been deemed successful as it is upholding all standards that were set within the masterplan (Nordhavnen: Inner Nordhavn).



*Professional rendering of what the proposed Nordhavn masterplan could be envisioned looking like in the future.*

# SOCIAL ACCEPTABILITY

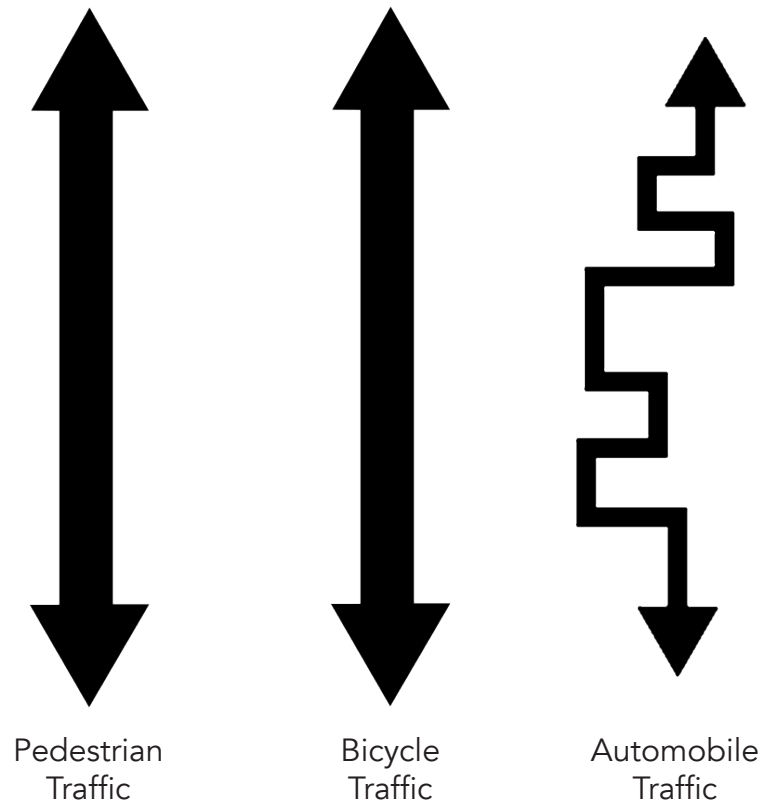
The successfulness of the project is ultimately decided by those people who visit and/or live within the future Nordhavn. Due to its central location in comparison to the City Center of Copenhagen and the surrounding districts, it is assumed that the development will attract residents, visitors, businesses, and overall labor resources from the entire region. Throughout the creation of the masterplan leading up to its unveiling in 2009, the three different design firms had been **in close dialogue** with its residents, future users, and stakeholders (Nordhavnen: Inner Nordhavn). Specifically, the masterplan laid out many opportunities for different activities throughout the entire district, promoting future social acceptability. In addition, the planners laid out the opportunity for diversity within the demographic to be later found within the soon to be development district (Nordhavnen: The Future of Sustainable Urban Living).

"A city for everyone."

Nordhavn **should** be open to everyone"

- BY & HAVN

Greater Copenhagen Area Development Firm



*Diagram Illustrating the focus that all of Nordhavn will allocate to pedestrian and bicycle traffic and just allow cars to maneuver around all of the different forms created.*

# FUNCTIONALITY (UTILITAS)

Throughout the process, district individuality was stressed, while recognizing its existence within the greater Copenhagen area. Overall, the new development will be able to **house over 3,000 residents** and offer **workspaces for 6,000 – 7,000 people**. Bringing this into percentages, upon completion Nordhavn will be comprised of roughly 40 percent commercial architecture, 40 percent residential architecture, and 20 percent left open as a **'flexible zone'**. This flexible zone allows for future changes and facilitates design changes in order to meet the district's end goal (Nordhavnen: Inner Nordhavn).

Specifically, the street layout of the district will enact the **'staggered street layout'**. This layout staggers each of the streets upon crossing an intersection which accommodates different design aspects. Firstly, it minimizes the negatives of the wind tunnel effect. Secondly, it will slow down the automobile traffic, ultimately giving the district back to pedestrian traffic. Lastly, this layout creates different public spaces and zones throughout the district. Overall, staggering each of the streets has a large sustainability beneficial impact with such a small input (Nordhavnen: Inner Nordhavn).

# ECONOMIC VIABILITY

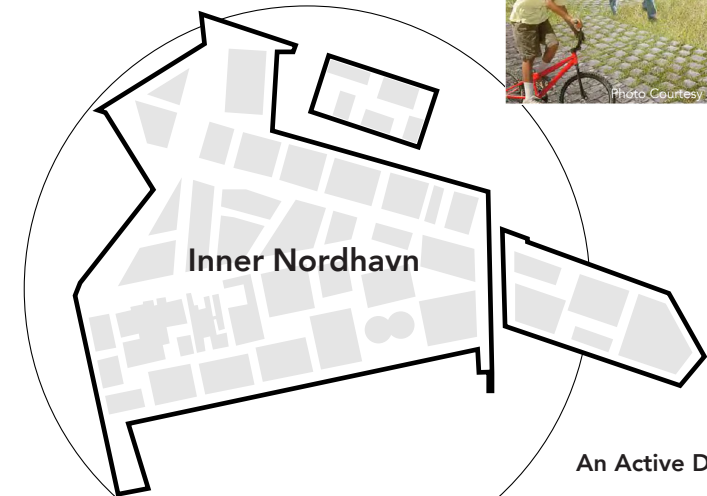
In the future, it is projected that the population of Copenhagen will **increase from 540,000 people to roughly 640,000 people**. The development of Nordhavn allows for this growth with minimal growing pains for the city itself. Overall, the future district is intended as a **dynamic city district** that features different environments intended to invite new initiatives. These can range from public institutions to shopping facilities that bring in new people, new experiences, and new jobs (Nordhavnen: Inner Nordhavn).

Moving forward regarding specific buildings, the designers and developers of Nordhavn will have to ensure economic viability and social equality for all residents. This facilitates diversity vs an economic based approach to planning (Nordhavnen: Inner Nordhavn).

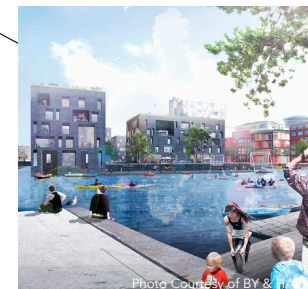


A Compact District

A District with Constraints



A Sustainable District



A Waterfront District

*Diagram illustrating the different aspects that are imagined to all be included within the final masterplan of the Nordhavn District.*

# DURABILITY (FIRMITAS)

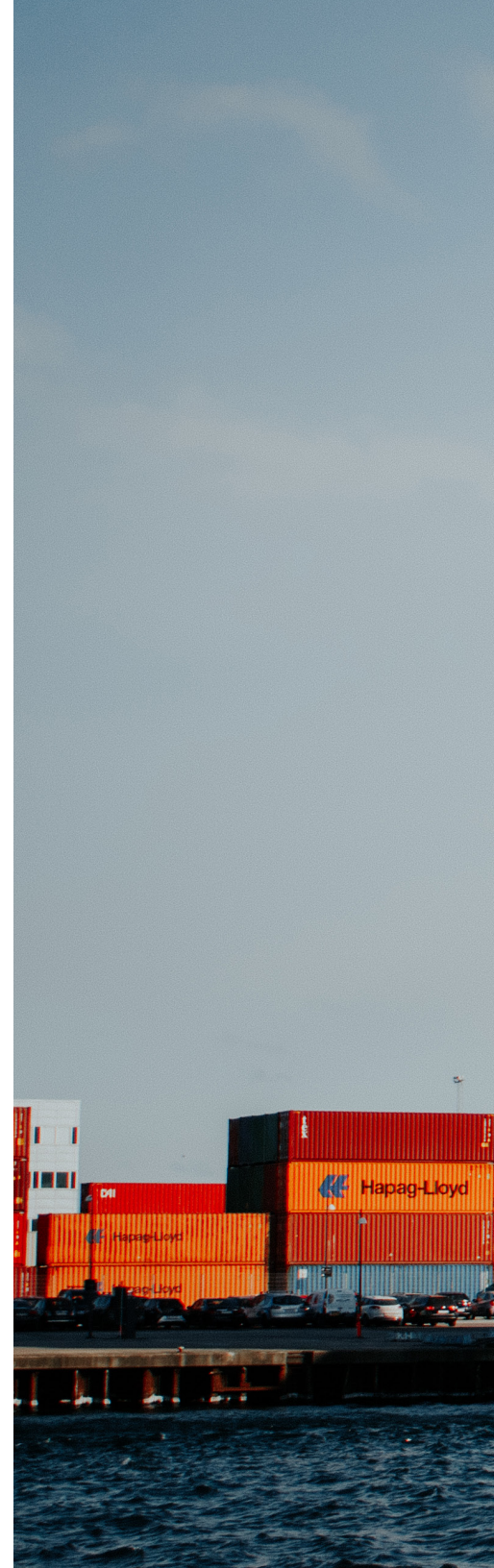
The overall durability of the new Copenhagen district is built around the fact that Nordhavn is not an isolated district, rather an **integral part of Copenhagen** while still maintaining its own special identity. Also, being comprised of a futuristic plot ratio of 1:8, Nordhavn will be less dense in comparison to the other districts of Copenhagen, which ultimately allows for growth

even after its completion date of 2050. In the end, Nordhavn was built around a gestalt, holistic approach, which states that all of the pieces are needed to ensure for the success of the whole, and no single piece can work on its own. This will create the new future sustainable district of Copenhagen (Nordhavnen: Inner Nordhavn).



*Diagram illustrating the evolution of the Nordhavn peninsula throughout time and how the area is projected to look like in the future.*











# COPENHAGEN INTERNATIONAL SCHOOL

## *Scale Two*

The Copenhagen International School (a.k.a. CIS), founded in 1963, is the largest school in all of Denmark. Previously located in Hellerup and Østerbro, the school outgrew both locations and was **in need of one unified, large location** (ArchDaily). Coming together, C.F. Møller architects designed a new school found within the new expansion of Nordhavn that allows for and facilitates the growth that CIS is currently going through. Designed to enroll 1,200 students and employ 280 teachers, the school currently teaches students ranging from 3-19 years old, originating from over 80 different countries (Millan, Agustin).

Overall, the building is comprised of a double-height space which acts as a podium for four separate towers which each host their own age groups: early years, primary school, secondary school, and high school). This construction was creating very closely in regard to being as sustainability driven as possibly. The board of directors separates sustainability into two main parts: natural materials and a psychological factor which states that **“it takes time to build something that will sustain itself”** (CIS Nordhavn Campus). Overall, this school has been noted as a framework to be followed by the rest of the world for putting sustainability on the fore-front and allows for the functions of the building to teach the students learning within.





# ENVIRONMENTAL PERFORMANCE

Being built around the idea of 'The Sustainable School', the Copenhagen International School implements an abundant number of features that all lead to its success within the category. First, the entire façade of the school is comprised of **12,000 solar panels** (6,048 m<sup>2</sup>) which produce over 50 percent of the school's energy usage. The solar panels produce around 30 MWh per year which is approximately equivalent to 70 single family detached homes (Millan, Agustin). The orientation of the entire building is meant to add to this solar catchment by offering the longer sides of the building to catch most of the sun, while the short ends are found on the east and west sides (Eldredge, Barbara). Second, the school is also designed using high performance insulation. This can be found within all of the walls, but also in the windows. The windows utilized have the capability to **heat or cool any space while always letting light into the building**. Also, the placement of key windows

is in attempt to increase the daylighting of the entire building, and also allow for as much passive ventilation as possible. On a smaller scale, every day, any uneaten food from the cafeteria is recycled to a nearby pig farm. Also, all of the cardboard or paper used in the cafeteria or any other facility is compressed and then sold for a profit (Ecowatch). Overall, the CIS building is comprised of numerous types of sustainability features that all lead to its incredible success as an environmentally sustainable school.

## Unstated Sustainability Features

- o Ventilation
- o Passive solar design
- o High insulation values
- o Rainwater harvesting
- o Prefab components
- o Noise Minimization
- o Low energy standard (2020)

# AESTHETICS (VENUTAS)

The Copenhagen International School has many different qualities that all lead to its aesthetic appeal. First and foremost, the **materials chosen** for the entire school. Unlike many different schools, almost all of the floors are covered in a modular - plug-in - oiled Oakwood material. This material is very expensive but also allows for a warm feeling inside and can be easily cleaned or exchanged in the event of damage. Also, all of the different sofas used are upholstered wool along with the bookshelves being made out of solid bamboo. Stepping back, we can also see that the floor-plan of the entire building is laid out to be **as open as possible** (ArchDaily). Utilizing large glass curtain-walls was in an attempt to allow the classrooms to become as open and spacious as possible. Also, this technique is then able to double as a day lighting strategy as well. This then leads into the entire building utilizing natural lighting to its fullest potential. Since the school is located in Denmark, it is very key for learning pupils

to experience as much light as possible throughout the day. Lastly, looking back at the solar panels we can see yet another aesthetic move. The color, and skew of each of the solar panels is done systematically in order for the entire façade to look like a wall of **sequins shimmering throughout the day** and to be able to optimize the overall workload of the solar panels (C.F. Møller).

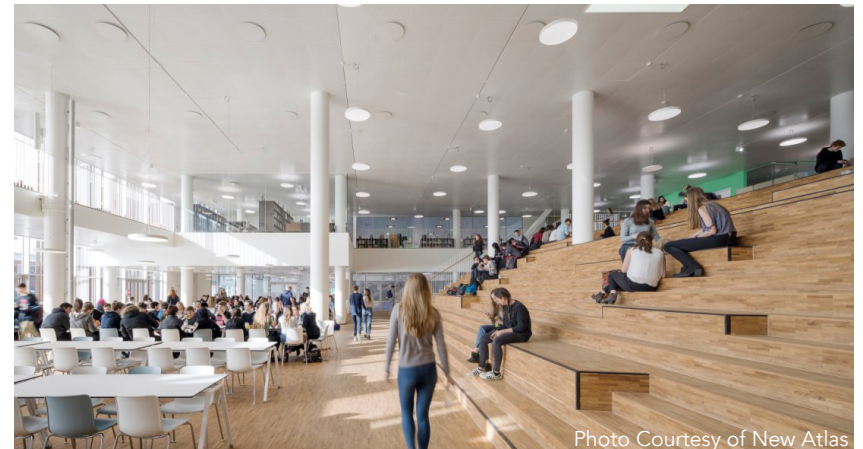


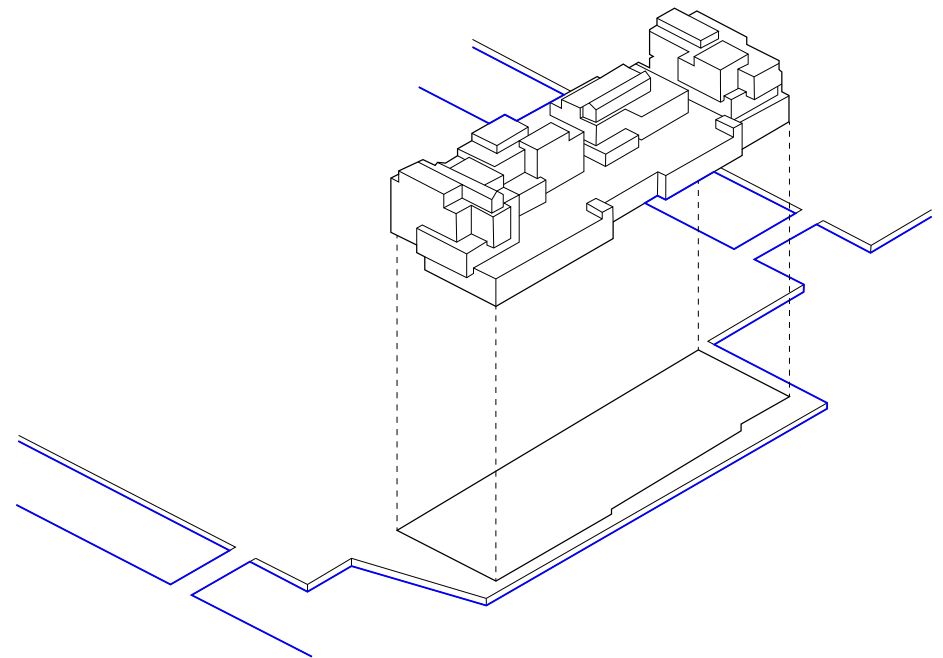
Photo Courtesy of New Atlas

"The modern educational architecture is designed to link the school's premises with the public sphere in the urban environment, and give the school an open ambiance."

**- C.F. MØLLER**  
Århus, Denmark based Architecture Firm

# SOCIAL ACCEPTABILITY

With the success that the Copenhagen International School has had within their new establishment, it has fallen short within the social acceptability category. Even though it is Denmark's largest school, it is a private school that is able to collect tuition for its students, and the **tuition is respectively high**. This leads to the school being quite challenging to fund, unless you are funded with wealth from your parents. However, the school does a tremendous job **incorporating sustainability into its curriculum** and allowing the school itself to do a lot of the teaching (CIS Nordhavn Campus). Students will follow the energy production of the school and utilize the data, among other things in physics and mathematics in accordance with the solar panels. With there being both positive and negative draws in regard to the social acceptability, CIS is able to source nearly 930 students already within its first year of education, which is more than acceptable.

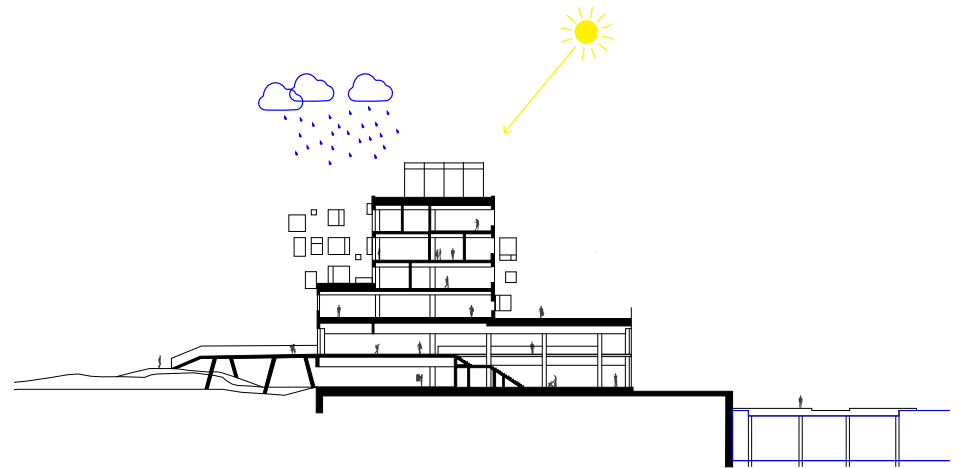


*Diagram illustrating the placement of the Copenhagen International School within the industrial harbor Nordhavn Site. This placement leaves the school surrounded by water on three of its four sides.*

# FUNCTIONALITY (UTILITAS)

The unconventional layout of CIS ultimately leads it to be an extremely functional school while still being able to host 1,200 students. As stated previously, the school is comprised of a common public space that stretches the entire footprint of the building that also **acts as a podium for the four educational towers** (Early years, Primary School, Secondary School, and High School). Each of these towers varies in height from five to seven stories tall (Copenhagen International School - Nordhavn). This layout also **offers the schoolyard to be raised to the second floor** of the building to offer more security from the industrial site location and the waterfront as well. Within each of the towers, the classrooms are located at each of the corners to allow for a maximum amount of sunlight to reach the students. Lastly, the layout, diving the public lower areas with the education towers offers the facility to be transformed into a public venue in the case of a school dance, or

any other public activity. In the future the school also hopes that this functional layout will aid in it being able to open its doors for use outside of the school hours (ArchDaily).



*Diagram illustrating the sectional quality of the building and how it is submerged into the site. Also illustrated is the broad sustainable weather solutions instituted into the building.*

# ECONOMIC VIABILITY

The Copenhagen International School's total expenditure was roughly **500 million DKK** (\$82,628,602.67 USD). This total was made possible through the aid of different donations and also Danske Bank. The different donations were met by the international corporations whose future employees would be sending their children to the school (ArchDaily). This relationship between the school being an international school, and the corporations needing to send their employees children to a school lead to the creation of the Copenhagen International School that we all know today (C.F. Møller).

- Donations

- o DKK 350 million

A.P. Møller og Hustru Chastine Mc-Kinney

Møllers Fond til almene Formål

Nova Nordisk Foundation

Villum Foundation

- Grants

- o DKK 100.1 million

Awarded to co-fund several aspects focusing on science and health, including furnishing innovative and advanced learning facilities.

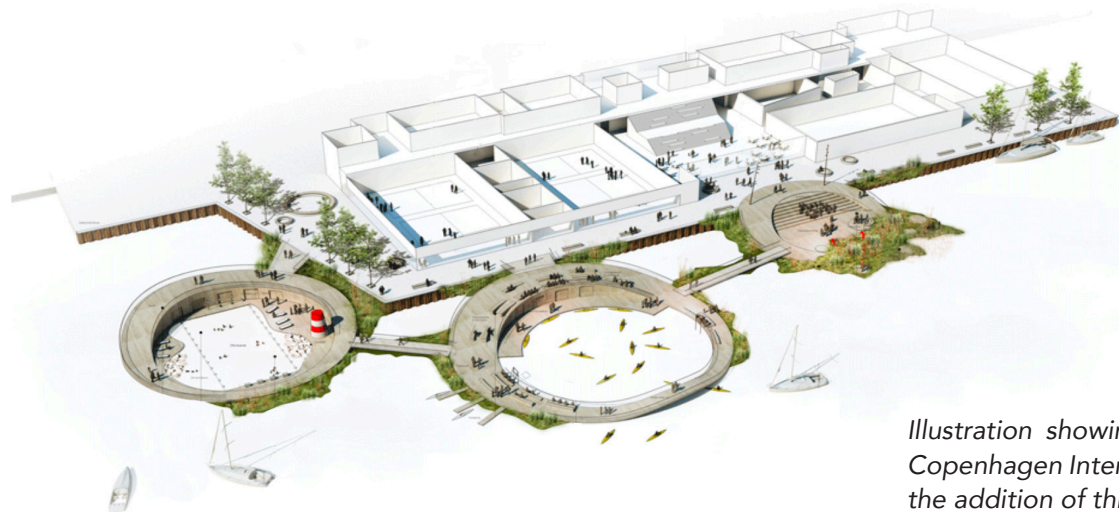
- o DKK 15 million

Awarded for providing scholarship to the children of international researchers employed at public research institutes in Denmark.

# DURABILITY (FIRMITAS)

Built within a very rapidly changing environment, the Copenhagen International School had to be built to stand the test of time. Since currently the school is situated within a very industrial shipping context it fits into with the modular exterior look and the blue-green color of the solar panels. In years to come, however, the school will need to fit into the newest district of Copenhagen (Nordhavn). Overall, the school was built in an attempt to **make Denmark a more attractive location** for international employees, and thus the students as well. Looking towards the future, CIS has already drawn up

an extension of the school into the harbor stretched out in front of the school. The goal of the project is to create **three separate islands that are all connected via a singular walkway**. These islands will offer activities for students and visitors of Nordhavn for all types of weather (kayaking, boating, sunbathing, swimming, fishing, etc.). Also, the 'Harbor Baths' will double as classrooms for the students of CIS, offering yet another style of education that the school offers for its students (Dezeen).



*Illustration showing the future extension of the Copenhagen International School into harbor with the addition of three different bathing areas.*











# THE SILO

## *Scale Three*

The Silo is a prestigious residential apartment building found within the newly developed Nordhavn area. Being part of the **industrial revitalization** efforts and the **master planning of Nordhavn's post-industrial area**, the Silo is built around the bones of the largest grain silos in the area. Built by the architecture firm COBE, the apartment building is in total 10,000 m<sup>2</sup>, amassing from 17 stories (62 meters tall) containing 38 unique apartments (COBE Completes Construction

of the Repurposed Silo Residence in Copenhagen). Each of these apartments size ranges from 106 m<sup>2</sup> to 401 m<sup>2</sup> with single to double height ceilings and dual leveled apartments. Capping all of these apartments are two public spaces that are found on the top and bottom floors. A major design aspect of the Silo was not only to create a refuge for the residence, but also a destination for Copenhageners and tourists alike (The Silo Copenhagen. e-Architect).



# ENVIRONMENTAL PERFORMANCE

The Silo was constrained by the existing infrastructure, therefore all major moves had to be made in moderation. One of the most striking features about the building is the exterior façade. Instead of the concrete exterior that the grain silo had, COBE decided to wrap the building in a **galvanized steel skin** (O Silo / COBE. ArchDaily). This move was made in order to create a livable environment within the building. The galvanized steel façade that encases the entire building acts as a **weather shield and protects all of the inhabitants living within**. Each of the different modules that created the façade were prefabricated and then plugged together to fit onto the preexisting silo. This led to a quick construction phase. Overall, the entire concept of the building is to fit into its context and to follow the **urban renewal concept** that has taken Copenhagen by storm (COBE

Transforms Copenhagen Grain Silo into Apartment Block). By allowing the apartment to fit within the old silos parameters, the Silo serves as a precedent for more buildings to come in the future (The Silo | Architecture | VisitCopenhagen).



*Image showing the installation of the modular galvanized steel facade and how it was then attached to the pre-existing grain silo. This process overall added to the environmental impact of the building but also the speed in which it could be completely built.*

# AESTHETICS (VENUTAS)

Many different parts of the Silo are aesthetically pleasing to the viewer. From the raw exterior cladding material chosen which reflects the raw concrete interior of each of the rooms, to floating 360-degree panorama room atop the building, the Silo is a jaw-dropping building. Overall, however, COBE was able to tease through and outline **four main architectural concepts that were used to create the unique housing qualities** (The Silo. COBE). First, from every apartment, there is a panoramic view towards the outdoors. Second, there are special room heights for each floor which makes the apartments unique and specially varied, while creating a variety of apartment types. Third, there are large balconies and useful outdoor spaces with views in up to three directions. Lastly, there is a special relationship to the silo's existing structure, such as the exposed concrete found within. Along with these four architectural tools used, there was a focus also put on the floating

element placed atop of the building. COBE states that "from here, there is a unique view over the skyline of Copenhagen, Øresund, and the horizon. This is [the area] where the **public life unfolds – in heaven**" (The Silo. COBE - The Silo).



"Architecturally, there is a contrast to the existing silo by introducing one new reflective glass façade. In daylight, the glass reflects its surroundings – the sky, the water, the horizon, and the skyline. In the evening, the façade is exposed on top and, on the other hand, radiates with light from within."

- DAN STUBBERGAARD  
Founder and Creative Director - COBE

# SOCIAL ACCEPTABILITY

The Silo was constructed not only as an apartment building but also a public space, this leads to the uniqueness of its design. COBE built the Silo to have **flexibility according to the user's needs**, so that the apartment could later be decorated with multiple rooms or a simple open plan. Each of the 38 apartments **have their own character and are truly the resident's home** (The Silo. COBE - The Silo). However, with all of the amenities that the Silo has to offer for its residents, it is listed as the **most expensive apartment building in Denmark**. For this reason, as prestigious as the apartment is, not all rooms are filled even to this day.

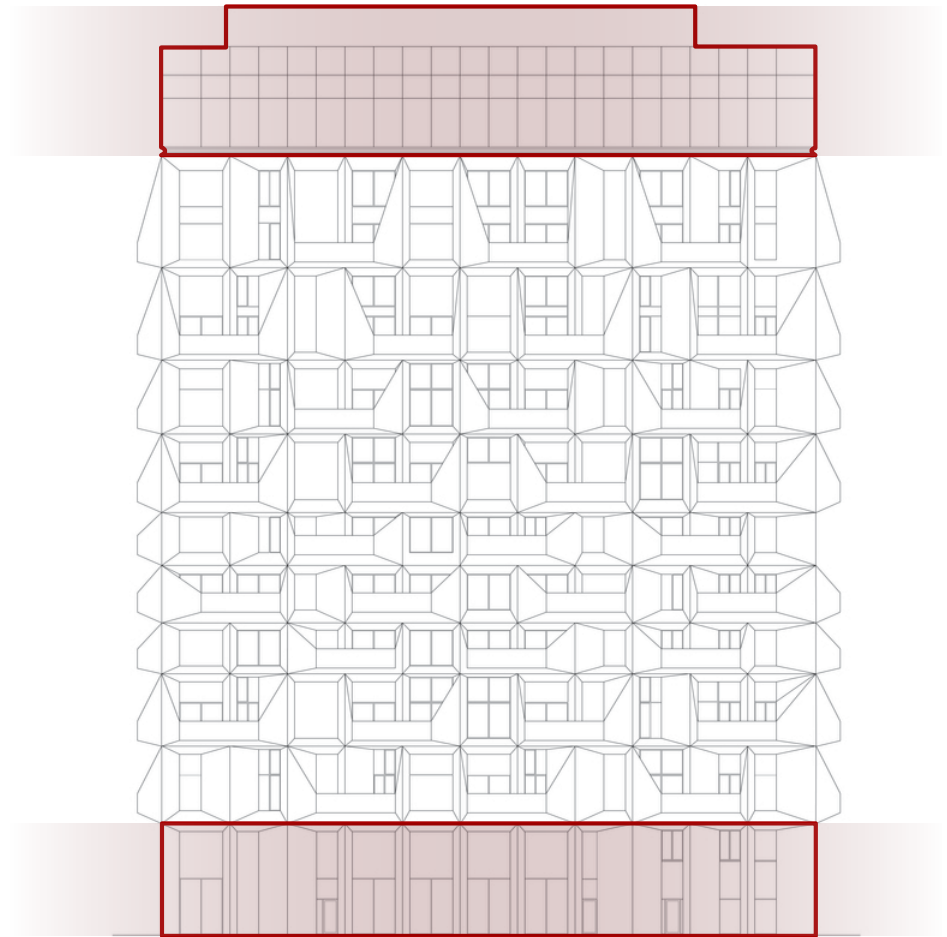


Photo Courtesy of Arch Daily

*Image stressing the individuality the Silo has in comparison to the buildings that comprise the surrounding area.*

# FUNCTIONALITY (UTILITAS)

The apartments are sandwiched between two different styles of public space , increasing the functionality of the entire building. Presently, the bottom floor is configured as an art gallery, and the top floor is a restaurant and viewing area. However, it was in the design interest that these **spaces have flexibility to change as time progresses** (The Silo. COBE - The Silo). Within the two sections of public space, one can see the residential necessities as well: manned reception desk, private fitness room, private parking spots, direct access to the lift, etc (NRE). Zooming out, one can observe the functionality of the façade. Attaching to the preexisting silo, the use of the façade allows the apartment building to effectively regulate temperature, while keeping the **slender and unobtrusive shape** (Wang, Lucy).



*Diagram illustrating the two end-capping public spaces that are then separated by the residential private spaces.*



# ECONOMIC VIABILITY

As previously stated, the average monthly rent for each of the rooms ranks the **most expensive in Denmark**. Because of this, the overall economic viability of the building is limited to societies upper tier income earners. Not all types of people from every background have a chance to be able to rent or own any of the properties within the building (NRE). Looking into the specifics of the apartment pricing we can see that:

- o Rent per month = DKK 24.000,00  
(\$3,847.50 USD)
- o Upfront Deposit = DKK 72.000,00  
(\$11,542.50 USD)
- o Rent (including utilities) = DKK 25.000,00  
(\$4,007.81 USD)
- o Utilities (to landlord) = Heating and Water
- o Utilities (to supplier) = Wi-Fi and Electricity

Data Sourced from NRE

*Both images show the building during the construction process. This is to clearly highlight the use of the steel facade to give the entire building a chic appearance which ultimately leads to its economic viability.*



Photo Courtesy of Arch Daily



Photo Courtesy of Arch Daily



# DURABILITY (FIRMITAS)

Based around the concept of **urban renewal from the industrial area of Nordhavn**, the Silo was built in regard to the past, present, and the future (COBE Completes Construction of the Repurposed Silo Residence in Copenhagen). Named an apartment building, the Silo also does its best to be a **destination for non-residents and Copenhageners alike**. Also, since COBE was one of the selected firms to masterplan the entire Nordhavn area, the Silo was created in regard to the future plan to be able to adapt and to ensure the buildings durability (Griffiths, Alyn).

"Ensures that the silo becomes one initiative and a milestone for the future development of the North Sea and the Århusgade neighborhood."

- DAN STUBBERGAARD  
Founder and Creative Director - COBE



Photo Courtesy of Arch Daily

*Image showing the everlasting concrete structure that was utilized as the sub-structure for the Silo. This act pushed the building's overall durability to the forefront of design and offered an easy solution.*

# DRAWING CONCLUSIONS

This research project used three separate building scales in order to gain valuable information regarding sustainability. Scandinavian countries of Europe have progressed within the sustainability realm of architecture and they are a great location to base the different case

studies from. Within each case study, the research was broken down into six categories previously discussed. Transferable findings can be identified to help the Midwest progress in their sustainability movement, as Scandinavian countries have successfully done.



# ENVIRONMENTAL PERFORMANCE

The 'Environmental Performance' is a crucial necessity for a building to be considered Sustainable. Within the three case studies, one can observe two different ways that a building can increase its environmental performance. In the case of the Copenhagen International School, many of the well-known mainstream sustainable methods were used, such as natural daylighting and solar panels. The difference lies in the way these methods were used in comparison to most other examples. The school utilized passive daylighting and ventilation while offering a open floor plan to diminish the maze-like factor and confusion often present within a stereotypical school. In addition, the school utilized many solar panels to be able to power the school. Where and how they used them is the difference maker. Placing solar panels as the entire façade of the building is a transferable precedent to use in future project, especially within the Midwest. Because of the sun path and longitudinal placement of Minneapolis in comparison to

Copenhagen, this may actually prove to be more productive on building within the Midwest. The second way of increasing the environmental performance of a building of 'urban renewal' was introduced by COBE through the development of Nordhavn, and the renovation of the Silo. By utilizing the urban fabric that had previously been laid down, architects limit their ecological footprint and also predetermines the design guidelines. Zooming out to an urban design scale, many different environmental performance tools were used by COBE. Street spacing and introducing and pushing for the use of public transportation are some main tools utilized. Both of these tools are easily transferable due to their inverse relationship with the climate. Overall, each of the three case studies provide transferable information in the 'Environmental Performance' category, which the Midwest can easily implement.

# AESTHETICS (VENUTAS)

First impressions are everything, even with architecture. Having a building be aesthetically pleasing and nice to look at plays into a lot of the different categories. For example, if a building is more pleasing to the eye, it is going to be more socially accepted ... and so on. Within each of the case studies researched, there is a high level of aesthetic appeal. On the urban design scale, all of Nordhavn is expressed in a way that is attractive to anyone looking through the submitted drawings due to a consistent color theme and interesting content. At the commercial scale, the Copenhagen International School wisely chose materials throughout the school. With a consistent use of soft colored wood for the flooring, bamboo for the bookshelves and a natural wool for the sofas, the school has a welcoming feel. However, each of the materials comes with a high cost, which can be seen within the final bill for the project. Something that should be taken away from this project is the fact that, from the beginning, the

architects must have the frame of mind to design for a certain atmosphere that was completed by the chosen materials. There must always be a discussion to understand that the aesthetic appeal (materiality) of a building must never be outweighed by the initial cost estimate. In addition, looking at the aesthetics of the Silo, an emphasis is put into the details and the use of raw materials. With the structure already determined by the pre-existing silo, COBE was able to turn its focus onto the specific details within the steel façade and the raw concrete materiality within each of the apartments. Each of the stated examples above are effective takeaways that can be implemented into the design of buildings within the Midwest. Becoming more attentive designers and outweighing the costs of simple materiality and detail choices truly moves mountains within the aesthetics of a building.

# SOCIAL ACCEPTABILITY

Social Acceptability is the foundation for any architecture project; sustainability driven or not. Without the acceptability of the population, the project will ultimately fail. In terms of sustainability, it is ever pressing for a project to be accepted by the people. In regard to the three case studies chosen, there are examples of how a project is able to become accepted by the population, or what creates a disconnect between a project and the people. For example, in regard to the Nordhavn Development, the project was based around a livable district. Keeping a commuter within 5 minutes from a source of public transportation and creating a very walkable city are two great tools in order to give the city back to the people. In doing so, the people will jump on board and back the methods of the project, thus creating a successful relationship between the project and the people. This method of designing can be brought back to the Midwest very easily. By giving public spaces back to the people and not the automobile, bringing the scale back to a human scale, and creating more open space, cities can become more people oriented and thus socially accepted. Switching scales and looking at the Copenhagen International School and the Silo, there is a very unique relationship happening. Designed

by large corporations and funded by even larger corporations, the buildings become less about the people, and more about a profit. At the Copenhagen International School, there are many different great tools and advanced techniques being used that all lead to it being admired by the population, but the tuition is the highest in all of Denmark. The Silo was built in context of the Urban Renewal phase that is sweeping across Copenhagen and is filled with amazing architectural details. However, the rent for each of the apartments is the highest in all of Denmark. For this reason, the building environment will not be a culturally, age, or economically diverse area for its inhabitants. In both examples, the project does a great job offering spaces for people, students, tenants, etc. to experience, but does not do a great job in making it affordable to allow for diversity across many different categories. These mistakes made by the great projects can be translated back to the Midwest and learned from so that they are not made again. Overall, I feel that all architecture projects – especially sustainability projects – will struggle adapting and truly allowing for diversity. It is a very hard concept to account for but learning from previous revered architecture project's mistakes may be the key in doing so.



# FUNCTIONALITY (UTILITAS)

Form follows function; the never-ending debate within architecture. A very essential portion for any piece of architecture, is 'how easy is it to function'? With focus put into so many different categories, sustainability project must never loosen the grip on putting function first and understanding that it is a major portion of any project. For each of the chosen case studies, the projects do an excellent job in providing a very functional piece of architecture, while also incorporating many different moving pieces as well. The entire Nordhavn development is designed to be functional from the human being. The streets are designed to minimize the wind channel effect while offering pockets of green to give relief from the repetitive buildings. All locations are designed to be within a five-minute walk for ease of transportation throughout Nordhavn and into other districts of Copenhagen. There are countless amounts of examples on how the Nordhavn Development has chosen to place the functionality of spaces on the fore-front of design, all of which can be taken back to the Midwestern developments. With the layout of the Copenhagen International School, the functionality was established from the beginning of the design. By making such an irregular shape of a school they have

allowed for teaching to be contained into four towers, while always allowing for a public space to be located beneath. This model of a programmatic layout can thus be taken and learned from, understanding that just because the sprawling layout of most American high schools is what is ordinarily seen today, it is not the most successful. Being able to break from the norm and show people that there are better ways of laying out different types of projects is a definite take-away from the project. Lastly, in regard to the Silo, there is a note to be made about bring public space into a previously strictly private building. Capping the residents with two public spaces ultimately brings the building through a whole new evolution. Growing from just a residential apartment building to now an icon and place from Copenhageners and tourists alike to go and see. This method can be exploited and used throughout all private spaces. By adding public spaces to otherwise private buildings is a great method do advance the building into being more than it previously could have been. Overall, each of the case studies has their own unique approach to creating a functional project, each of which can be studied and utilized within nearly any type of architectural project.

# ECONOMIC VIABILITY

It is very hard to base the economic viability of different programs in regard to other nation's projects. Since there are completely different economies run by completely different systems, it is hard to make a meaningful comparison. However, something that can be looked at is how economically viable each of the case studies are, and then draw correlations to what can be done back in the Midwest. Firstly, looking into the Nordhavn Development, we can see that creating a completely viable region for all types of people is put on the forefront of the design. Setting standards for the exact types of buildings and the prices of living that should then be allocated to different buildings is a great step in the right direction to achieve this goal. Following these different rule sets allows for a sense of diversity both in age, culture, ethnicity, and status within the economy. This ultimately creates a better designed and more livable area. Secondly, looking at the Copenhagen Business School, the tools used are very specific to the environment the school is placed in.

For example, since most of the students that attend the school are children of expats, the school is widely funded by the companies that the expats are employed by. Because of this, the school was able to spend a large sum of money on the construction of the school. However, the tuition rate that the school charges the students is the largest in any school in Denmark. This, in the end, leads to the school not becoming as economically viable because it is segregated to not only expat's children, but also those who have enough money to pay for the tuition. Lastly, the Silo is the least economically viable out of the three case studies. This is because of the prices that are set on each of the apartments. The Silo is considered one of the most expensive apartments in Denmark thus creating a very ghetto-esque apartment building. Since the apartment was initially built as a high-end building, this result is very hard to not encounter. Overall, I feel that it is always important for architects to want diversity instilled into their projects in order to create an economically viable project for all.

# DURABILITY (FIRMITAS)

The longevity of a project is thoroughly determined by the overall durability of said project. In the end, this then relates back to the sustainability of the project. Looking at the three different case studies, we can see many different uses to create as much durability in a project as possible. Looking at the Nordhavn Development, we can see the use of a futuristic gestalt approach. In knowing that there will be an overall expansion of the Copenhagen population in the near future, the Nordhavn Development is designed to be able to work with this growth and facilitate it to its best ability. Along with facilitating growth, Nordhavn will also foster the identity of all of Copenhagen while also maintaining the already found identity of the area. This thought process can be applied to any further urban design development in the Midwest.

Looking into the Copenhagen International School we can see the use of constant redesign and evolving an already successful design. Just years after its completion, Møller was already extending the initial plan and designing new baths that extend into the harbor. This constant redevelopment and design will ensure is everlasting durability as a up-to-date school. Lastly, the Silo utilizes a very common thought process that is sweeping through Copenhagen at to this date: Urban Renewal. By designing a building within an already present skeleton, COBE was able to ultimately reuse an already created space and transform it into a readily usable public and private building. These two different process can both be used within future design within the Midwest and would thoroughly increase the durability of many buildings.

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